Thromboprophylaxis in orthopaedic surgery
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Ten-year follow-up on Dutch orthopaedic blood management

DATA III survey

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ABSTRACT

Introduction
Hip and knee arthroplasties are frequently complicated by the need for allogeneic blood transfusions. This survey was conducted to assess the current use of perioperative blood-saving measures and to compare it with prior results.

Materials and methods
All departments of orthopaedic surgery at Dutch hospitals were sent a follow-up survey on perioperative blood-saving measures, and data were compared to the results of two surveys conducted 5 and 10 years earlier.

Results
The response rate was 94 out of 108 departments (87%). Most departments used erythropoietin prior to hip and knee replacements at the expense of preoperative autologous blood donation. The use of intraoperative autologous retransfusion in revision hip (56 vs. 54%) as well as revision knee arthroplasty (26 vs. 24%), was virtually unchanged. Postoperative autologous retransfusion is still used by the majority of departments after both primary arthroplasty and revision of hip (58/53%) and knee (65/61%).

Conclusions
Currently, just as in 2007, the majority of Dutch orthopaedic departments uses erythropoietin, normothermia and postoperative autologous retransfusion with hip and knee arthroplasty. Intraoperative retransfusion is used mainly with hip revision arthroplasty. Other effective blood management modalities such as tranexamic acid have not been widely implemented.
INTRODUCTION

Blood transfusions are frequently required after hip and knee arthroplasties. Adverse events can occur after allogeneic red blood cell transfusions. These include infections due to contaminated blood, (incompatibility) transfusion reactions [1-3], increased risk of postoperative infection due to effects on the immune system [3-6], delay of wound healing and prolonged hospital stay [3,5]. It is therefore important to reduce the need for allogeneic blood transfusions. This can be achieved by increasing the patient’s haemoglobin level preoperatively, by reducing blood loss and by auto-transfusion. There is an increasing focus on perioperative blood management [7]. This survey was conducted to assess the current use of perioperative blood-saving measures and to compare it with the results of prior surveys and national guidelines.

MATERIALS AND METHODS

A questionnaire on orthopaedic departmental protocols for perioperative blood management measures was sent to all 110 orthopaedic departments in Dutch hospitals. It was tailored to fit similar ones conducted in 2002 and 2007 [7]. Response rates in 2002 and 2007 were 79% (87 out of 110 departments) and 84% (81 out of 96 departments). The power analysis showed that, with a confidence interval of 95%, the response of at least 86 of 110 departments was required for our analysis. The questionnaire was expanded to include newly-introduced blood-saving measures. The current choice of perioperative blood management measures with total hip, hemi hip and revision hip arthroplasty as well as total knee, hemi knee and revision knee arthroplasty were assessed. In 2012 a package with the questionnaire, a cover letter, and a stamped return envelope were sent to all these orthopaedic departments. Non-respondents were sent a reminder after four months, and were contacted by telephone if necessary. Categorical data and dichotomous variables were summarised as percentages of the responding departments by means of SPSS 21 (New York).

RESULTS

The questionnaire was ultimately answered properly by 94 out of 110 departments. Two clinics were excluded because they reported performing spine surgery exclusively. The adjusted response rate was therefore 87%. Eleven (12%) departments stated that they had no specific departmental protocol on blood-saving measures in 2012.
Preoperative blood-saving measures

The use of preoperative autologous blood donation has been steadily decreasing over the years and is currently used in only 4% of departments (Table 1). Compared to 2002, in 2007 there was a considerable increase in the use of erythropoietin for hip as well as for knee arthroplasty. Currently, the majority (50-60%) of orthopaedic departments continues to use erythropoietin after primary and revision hip and knee arthroplasty, although a slight decrease can be observed. Iron suppletion is being used by 27% of departments.

Table 2 shows the discontinuation of different anticoagulants and the associated time before operation. Most departments discontinue the various anticoagulants, except for non-steroid anti-inflammatory drugs (NSAIDS) and Cox-2 selective NSAIDS, which are stopped preoperatively by a minority (40%). Also noteworthy is the significant decrease in the number of departments that discontinues aspirin before the operation (P < 0.001).

**Table 1.** Preoperative blood-saving measurements used prior to arthroplasties of hip and knee in the studied orthopaedic departments N,(%)

<table>
<thead>
<tr>
<th>Arthroplasty</th>
<th>Preop. autologous blood donation</th>
<th>Erythropoietin</th>
<th>Iron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total hip</td>
<td>11 (14)</td>
<td>10 (11)</td>
<td>4 (4)</td>
</tr>
<tr>
<td>Revision hip</td>
<td>6 (8)</td>
<td>9 (10)</td>
<td>4 (4)</td>
</tr>
<tr>
<td>Total knee</td>
<td>7 (9)</td>
<td>8 (9)</td>
<td>4 (4)</td>
</tr>
<tr>
<td>Revision knee</td>
<td>4 (5)</td>
<td>8 (9)</td>
<td>4 (4)</td>
</tr>
<tr>
<td>Hemi knee</td>
<td>2 (3)</td>
<td>6 (7)</td>
<td>2 (2)</td>
</tr>
</tbody>
</table>

*a Significance of difference between 2007 and 2012 data is calculated

**Table 2.** Cessation of anticoagulants preoperatively, prior to arthroplasties of hip and knee in the studied orthopaedic departments N,(%)

<table>
<thead>
<tr>
<th>Anticoagulant</th>
<th>Discontinuation of medication</th>
<th>Days prior to operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSAIDs</td>
<td>36(41)</td>
<td>33(36)</td>
</tr>
<tr>
<td>Cox-2 selective NSAIDs</td>
<td>NA</td>
<td>37(40)</td>
</tr>
<tr>
<td>Acetylsalicylic acid</td>
<td>72(83)</td>
<td>50(54)</td>
</tr>
<tr>
<td>Clopidogrel</td>
<td>NA</td>
<td>77(84)</td>
</tr>
<tr>
<td>Dipyridamol</td>
<td>NA</td>
<td>64(70)</td>
</tr>
<tr>
<td>Aacenocoumarol</td>
<td>87(100)</td>
<td>90(98)</td>
</tr>
<tr>
<td>Fenprocoumon</td>
<td>87(100)</td>
<td>90(98)</td>
</tr>
</tbody>
</table>

*a Significance of difference between 2007 and 2012 data is calculated

b Mean and range

* Significant difference
Intraoperative blood-saving measures

Intraoperative retransfusion is predominantly used during revision hip arthroplasty (56% of departments) (Table 3). A further decrease in use of cell saving is observed in primary hip and knee arthroplasty, compared to 2007 and 2002. Normothermia and tourniquets are used by most departments. Tranexaminic acid is used by 8-15%. The use of other techniques, such as epinephrine injections, acute normovolemic hemodilution and controlled hypotension, are listed in Table 3.

### Table 3. Intraoperative blood-saving measurements during arthroplasties of hip and knee in the studied orthopaedic departments N,(%)

<table>
<thead>
<tr>
<th>Arthroplasty</th>
<th>Intraoperative retransfusion</th>
<th>TA</th>
<th>NT</th>
<th>T</th>
<th>FG</th>
<th>PG</th>
<th>Epi</th>
<th>ANH</th>
<th>CH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>‘02</td>
<td>’07</td>
<td>‘12</td>
<td>P</td>
<td>’12</td>
<td>’12</td>
<td>’12</td>
<td>’12</td>
<td>’12</td>
</tr>
<tr>
<td>Total hip</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12(15)</td>
<td>17(19)</td>
<td>13(14)</td>
<td>0.06</td>
<td>13(14)</td>
<td>68(74)</td>
<td>NA</td>
<td>0</td>
<td>0</td>
<td>3(3)</td>
</tr>
<tr>
<td>Revision hip</td>
<td>32(40)</td>
<td>47(54)</td>
<td>52(56)</td>
<td>0.73</td>
<td>14(15)</td>
<td>67(73)</td>
<td>NA</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hemi hip</td>
<td>5(6)</td>
<td>10(12)</td>
<td>6(7)</td>
<td>0.07</td>
<td>7(8)</td>
<td>67(73)</td>
<td>NA</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total knee</td>
<td>8(10)</td>
<td>12(14)</td>
<td>8(9)</td>
<td>0.06</td>
<td>11(12)</td>
<td>66(72)</td>
<td>83(90)</td>
<td>1(1)</td>
<td>1(1)</td>
</tr>
<tr>
<td>Revision knee</td>
<td>13(16)</td>
<td>21(24)</td>
<td>24(26)</td>
<td>0.85</td>
<td>12(13)</td>
<td>65(71)</td>
<td>80(87)</td>
<td>1(1)</td>
<td>1(1)</td>
</tr>
<tr>
<td>Hemi knee</td>
<td>5(6)</td>
<td>10(11)</td>
<td>7(8)</td>
<td>0.17</td>
<td>8(9)</td>
<td>67(73)</td>
<td>78(85)</td>
<td>1(1)</td>
<td>1(1)</td>
</tr>
</tbody>
</table>

* Significance of difference between 2007 and 2012 data is calculated

TA = tranexaminic acid, NT = normothermia, T = tourniquet, FG = fibrin gel, PG = platelet gel, Epi = epinephrine injections or lavage, ANH = normovolemic hemodilution, CH = controlled hypotension

Postoperative blood-saving measures

The marked increase in the use of postoperative autologous retransfusion observed in 2007 was maintained, and the majority of departments still uses retransfusion drains in 2012 (Table 4). A slight increase is observed with hemi hip and hemi knee arthroplasty. Blood transfusion was done according to the 4-5-6-transfusion trigger rule [8] in all

### Table 4. Postoperative blood-saving measurements after arthroplasties of hip and knee in the studied orthopaedic departments N,(%)

<table>
<thead>
<tr>
<th>Arthroplasty</th>
<th>Postop. autologous retransfusion</th>
<th>No drain</th>
<th>Compression bandage</th>
<th>Cryo-therapy</th>
<th>Leg elevation</th>
<th>Fixed flexion knee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total hip</td>
<td>11(14)</td>
<td>50(58)</td>
<td>53(58)</td>
<td>0.97</td>
<td>26(28)</td>
<td>28(30)</td>
</tr>
<tr>
<td>Revision hip</td>
<td>10(13)</td>
<td>47(54)</td>
<td>49(53)</td>
<td>0.91</td>
<td>19(21)</td>
<td>28(30)</td>
</tr>
<tr>
<td>Hemi hip</td>
<td>6(8)</td>
<td>36(41)</td>
<td>43(47)</td>
<td>0.41</td>
<td>26(28)</td>
<td>24(26)</td>
</tr>
<tr>
<td>Total knee</td>
<td>19(23)</td>
<td>61(70)</td>
<td>60(65)</td>
<td>0.41</td>
<td>23(25)</td>
<td>58(63)</td>
</tr>
<tr>
<td>Revision knee</td>
<td>12(15)</td>
<td>51(59)</td>
<td>56(61)</td>
<td>0.85</td>
<td>17(19)</td>
<td>57(62)</td>
</tr>
<tr>
<td>Hemi knee</td>
<td>6(8)</td>
<td>42(48)</td>
<td>49(53)</td>
<td>0.54</td>
<td>27(29)</td>
<td>55(60)</td>
</tr>
</tbody>
</table>

* Significance of difference between 2007 and 2012 data is calculated
departments, except for three. Thirty-three percent of departments used Cox-2 selective NSAIDS postoperatively, instead of non-selective NSAIDS.

CONCLUSIONS

Principle findings
The use of perioperative blood-saving measures is varied but standard in the Netherlands. The most-used modalities are erythropoietin, normothermia, tourniquets in knee surgery, retransfusion drains, and the 4-5-6-transfusion trigger. NSAIDS and aspirin are less frequently discontinued preoperatively than before, and effective blood-saving measures such as tranexamic acid are not implemented by the majority of departments.

Strengths and weaknesses
We believe the results of our survey are valid, because the high survey response (84, 79 and 84%) limits non-responder bias. Furthermore, we included a very complete list of possible blood-saving measures. Potential weaknesses are those common to postal surveys: lack of control over who completes the questionnaire and potential inaccuracy in the information provided. This represents an audit of practice, without additional information on the reasons for the responses given. Also, we did not quantify the frequency with which different blood-saving measures were used in individual departments in this and previous surveys.

Meaning of findings
Only two comparable surveys could be identified. A 2006 Scottish questionnaire on hip revision arthroplasty showed that 10 out of 62 (16%) orthopaedic surgeons routinely used intraoperative cell salvage, 11% used postoperative cell savage, 3% routinely used tranexamic acid and 73% used a transfusion protocol [9]. By contrast, our survey shows that 56% of departments uses intraoperative cell salvage and 53% postoperative cell salvage. Thirty-two percent of Scottish surgeons stated that cell salvage was not available. The other survey was conducted amongst 81 Dutch orthopaedic departments in January 2012 [10]. Post-operative drainage and retransfusion and erythropoietin were used most frequently, in concordance with our analysis. The frequency of the use of blood saving measures after total hip or total knee arthroplasty was described as frequent (regularly, almost always or always) or non-frequent (never and almost never). No distinction was made between hip and knee surgery, nor between primary or revision surgery. The use of blood saving measures after hemi hip arthroplasty and hemi knee arthroplasty were not investigated.
Because blood loss varies between different types of surgery, e.g. hemi knee arthroplasty or revision hip arthroplasty, blood saving measures also vary: they are tailored to the type of surgery. Therefore in our study more details regarding type of surgery and a wider range of blood saving measures were described. Moreover, we were able to compare data from October 2012 to data from our two previous surveys with exactly the same design.

**Preoperative blood-saving measures**

Our study shows that only 4% of Dutch orthopaedic departments still uses preoperative blood donation, compared to 10% in 2007. Preoperative blood donation reduces the relative risk of receiving allogeneic blood transfusion. The risk on any transfusion (allogeneic of autologous), however, is augmented [11]. The infrequent use is in concordance with the Dutch guideline on blood transfusion [12], which advises using this technique with reticence due to complex logistics and relatively high costs.

The efficacy of erythropoietin in orthopaedic surgery has been demonstrated in several randomized controlled trials [13-15]. For patients with preoperative Hb>10 to ≤13 g/dl, epoetin alfa therapy dramatically increases perioperative Hb levels and reduces patient exposure to allogeneic blood transfusion [13,15]. Its costs, although reduced, remain an issue. Most departments currently use erythropoietin.

According to one report, 23% of patients with preoperative anaemia has an iron deficiency [16]. Iron, orally or intravenously supplied, decreases preoperative anaemia and is less expensive than erythropoietin. However, iron is not widely used in the Netherlands, even though the Dutch guidelines [12] advise correcting preoperative iron deficiency at least four weeks prior to major elective surgery.

**Intraoperative blood-saving measures**

Intraoperative retransfusion is predominantly used during revision hip arthroplasty (56% of departments), when substantial blood loss is to be expected. Intraoperative retransfusion is an effective method to significantly decrease the use of donor blood [12,17-19].

Hypothermia reduces the function of thrombocytes and coagulation factors, resulting in increased risk of bleeding [20,21]. Maintaining normothermia therefore aids in the reduction of blood loss. Currently, more than 70% of departments aims to maintain normothermia.

When the expected blood loss is at least 40% of circulating blood volume, Acute Normovolemic Hemodilution (ANH) is a safe and cheap technique to reduce the amount of allogeneic blood transfusions [22,23]. A reduction of 30% transfusions is observed, but results vary [24,25]. ANH is reportedly the most cost-effective method to reduce the
amount of allogeneic blood transfusions [12,26], but is not used often because of its extensive procedure.

Use of fibrin sealant can reduce the number of allogeneic blood transfusions. A Cochrane review and meta-analysis reported that fibrin sealant treatment reduced the rate of allogeneic red cell transfusions by 54% on average [27,28]. Other reviews emphasise its very promising use, especially in TKA [29,30], but more high-quality evidence is necessary. Not enough evidence is available to recommend the use of platelet-leucocyte-enriched gel as a local method for haemostasis [12]. Low rates of use in our survey may reflect clinical uncertainty.

Another very potent and cost-effective agent to reduce intraoperative blood loss is tranexaminic acid. Even though the Dutch guideline advises using tranexaminic acid, it is not widely used. Tranexaminic acid significantly reduces blood loss, number of blood transfusions and the number of patients that needs a blood transfusion [31] without increasing the risk on thromboembolic events.

**Postoperative blood-saving measures**

Compared to 2002, in 2007 a dramatic increase in the use of postoperative autologous retransfusion was observed. In 2012, the majority of departments used postoperative autologous retransfusion, as in 2007. This is in accordance with the Dutch guideline, which advises using perioperative auto transfusion in all cases of major surgery in which a great amount of blood loss is to be expected. A slight increase is observed with hemi hip and hemi knee arthroplasty. Reductions in the number of allogeneic blood transfusions of 55% are observed in orthopaedic surgery [19].

No drainage compared with closed-suction drainage without auto transfusion reduces the transfusion rates from 40% to 31% in THA, and from 50% to 31% in TKA [32]; 19-29% of the departments in our survey did not use a drain. The trigger for postoperative allogeneic blood transfusion was according to the 4-5-6 rule [8] in all departments, except for three. Restrictive transfusion strategies reduced the risk of receiving a RBC transfusion by 39%.

The combined use of multiple blood-saving methods is much more effective than a single technique [4,33,34]. With a blood management algorithm, allogeneic red blood cell transfusions can be reduced up to 80% [4,33,34].

In summary, our survey reveals that there is a positive attitude among orthopaedic surgeons towards blood saving measures. The use of perioperative blood-saving measures is varied but standard in the Netherlands in 2012, just as in 2007. The most-used modalities are erythropoietin, normothermia, tourniquets in knee surgery, retransfusion drains, and the 4-5-6-transfusion trigger. NSAIDS and aspirin are discontinued preoperatively
less frequently than before, and effective blood-saving measures such as tranexamic acid are not widely implemented.
REFERENCES


